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Urban and Regional Planners

M E M O R A N D U M

To: David de Cordova

From: Chris Ford

Re: Carlsbad Government Operations Greenhouse Gas Inventory Update – 2011

Date: June 18, 2013

This memo summarizes the approach taken to update the 2005 Greenhouse Gas (GHG) Emissions Inventory from City of Carlsbad government operations with 2011 data and compares the inputs and outputs. A separate memo covers community emissions, updated with 2011 data. That memo is referenced in this one to minimize repetition of information. The content of these memos will contribute to the summary of Carlsbad's GHG emissions in the forthcoming Climate Action Plan (CAP); the memos may be placed in an appendix to the CAP.

Technical terms and acronyms that appear in this memo are listed in Table 1.

Table 1: Technical Terms and Acronyms

CACP	Clean Air and Climate Protection software, a model developed by ICLEI to inventory and forecast GHG emissions
CAP	Climate Action Plan
CARB	California Air Resources Board, the agency responsible for setting statewide GHG emission reduction targets. CARB also maintains several GHG emission calculation models.
CO_2e	Carbon dioxide equivalents, a measure of GHGs that converts non-CO_2 emissions to the same impact as carbon dioxide
EPA	US Environmental Protection Agency
FTE	Full-Time Equivalent employees
GHG	Greenhouse gases, mainly carbon dioxide (CO_2), carbon dioxide, nitrous oxide (N_2O), and methane (CH_4)
ICLEI	An organization that provides standards and models for measuring and forecasting GHG emissions
SDG&E	San Diego Gas and Electric, the energy utility for Carlsbad
Service Population	Residents + employees, a rough measure of how many people may be generating emissions within a defined area.
VMT	Vehicle Miles Traveled, a measure of the annual amount of driving within an area, used to calculate GHG emissions from vehicles

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ASSUMPTIONS

As with the 2005 inventory, ICLEI's CACP[1] model was used to estimate emissions from local government operations across all sectors. Unlike with community emissions, CACP was the only model employed.

Three sectors analyzed— employee commute, stationary refrigerants, and solid waste—are "Scope 3" emissions. These emissions are not part of the government operations emissions inventory as they are indirectly caused by the City, but this memo reports on their impact.

Employees

Between 2005 and 2011, the number of full-time equivalent (FTE) employees at the City of Carlsbad increased by 4.2 percent, growing from 793 to 826 FTE. This percent change is used to estimate pro-rated increases in certain emissions since 2005.

Electricity Coefficients

Electricity coefficients measure how much GHG emission and air pollution is created by various sources of electricity generation. The government operations inventory uses the same electricity coefficients as the community inventory; see that other memo for a discussion on the increase in GHG emissions per megawatt hour from SDG&E electricity since 2005.

Natural Gas Coefficients

The default values in the CACP model were used; they are the same as those used in 2005.

Transportation

Local government emissions from vehicles were estimated using the CACP model. For NO_2 and CH_4 emissions, CACP only includes emissions factors through model year 2005. The CACP instructions include additional factors that can be manually entered for model years 2006-2008; we also got newer information from the latest *US EPA Inventory of US GHG Emissions and Sinks* report, the source used by ICLEI. This 2013 version of the EPA report[2] includes newer emissions factors, although the applicable date is not specified; the factors for gasoline are similar to the 2008 factors, therefore they were applied for model years 2009 onwards. Table 2 shows the emissions factors we entered into CACP for gasoline vehicles with model years of 2006 and later.

[1] The 2011 update utilized the CACP 2009 Version 3.0 software.
[2] We found the 2013 report, which includes newer factors in Annex 3 of the report, although the applicable date is not specified.
http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html

Table 2: Emissions Factors from Gasoline Fueled Vehicles, Model Years 2006 On

Fuel	*Vehicle Type*	*Model Year*	*NO_2 factor*	*CH_4 factor*
Gasoline	Passenger car	2006	0.0057	0.0161
Gasoline	Passenger car	2007	0.0041	0.0170
Gasoline	Passenger car	2008	0.0038	0.0172
Gasoline	Passenger car	2009+	0.0036	0.0173
Gasoline	Light trucks	2006	0.0089	0.0159
Gasoline	Light trucks	2007	0.0079	0.0161
Gasoline	Light trucks	2008	0.0066	0.0163
Gasoline	Light trucks	2009+	0.0066	0.0163
Gasoline	Heavy trucks	2006	0.0175	0.0326
Gasoline	Heavy trucks	2007	0.0173	0.0327
Gasoline	Heavy trucks	2008	0.0171	0.0327
Gasoline	Heavy trucks	2009+	0.0134	0.0333

Sources: 2006-08 model years from ICLEI Local Government Operations Inventory Instructions, referencing LGO Protocol table G.12: Based on U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008 (2010). 2009+ model years from EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011 (2013), Annex 3.

The 2013 EPA report's emissions factors for diesel are the same as for model years 1996-2004, so diesel vehicles were handled through the regular CACP calculation.

Solid Waste

The default values in the CACP model were used.

INPUTS AND METHODOLOGY

This section describes the data used to calculate 2011 emissions and the manner in which the data was acquired, transformed, and used. The table at the end of this section compares the 2005 and 2011 inputs.

Buildings and Other Facilities

The inputs for this sector are electricity and natural gas. Data was entered by individual facility with departmental information also entered. Since the 2005 inventory through 2011, a number of new or expanded facilities have been added to the City's operations: Fire Station No. 6, Senior Center expansion, Recycled Water Facility, Aviara Community Park, Hidden Canyon Park, Pine Avenue Park, The Crossings golf course, and the Hawthorne Equipment Building. During the same period, the Library Learning Center replaced the Adult Learning Center and Centro de Informacion. These additional facilities account for the majority of the change in electricity and natural gas consumption.

Table 3 lists all of the buildings and facilities operated by the city, comparing electricity and natural gas inputs between 2005 and 2011. Overall, the City's facilities consumed 21 percent more electricity and 10 percent more natural gas in 2011 compared to 2005.

Table 3: Building and Facilities Inputs

		2005		2011		% Change	
Department	*Building*	*Electricity (kWh)*	*Natural gas (therms)*	*Electricity (kWh)*	*Natural gas (therms)*	*Electricity (kWh)*	*Natural gas (therms)*
City	City Administration	1,099,520	1,430	1,203,726	1,738	9%	22%
City	City Hall	294,080	8,552	233,680	5,313	-21%	-38%
City	Farmers Insurance Bldgs	167,055	71	112,057	-	-33%	-100%
City	Hawthorne Equipment Bldg	N/A	N/A	10,040	-		N/A
City Total		**1,560,655**	**10,053**	**1,559,503**	**7,051**	**0%**	**-30%**
Community Development	Hiring Center	6,299	-	6,972	-	11%	
Community Development	Las Palmas	22,720	-	55,570	-	145%	
Community Development Total		**29,019**		**62,542**		**116%**	**-**
Fire	Fire Station No. 1	85,720	900	63,600	1,358	-26%	51%
Fire	Fire Station No. 2	29,847	676	32,643	1,069	9%	58%
Fire	Fire Station No. 3	33,713	525	33,972	675	1%	29%
Fire	Fire Station No. 4	31,434	544	28,867	1,062	-8%	95%
Fire	Fire Station No. 5	108,560	2,231	98,720	2,061	-9%	-8%
Fire	Fire Station No. 6	N/A	N/A	55,180	1,464	-	N/A
Fire Total		**289,274**	**4,876**	**312,982**	**7,689**	**8%**	**58%**
Golf Course	The Crossings			**1,056,015**	**18,019**	**-**	**-**
Library	Adult Learning Center	9,078	-	-	-	-	-
Library	Cole Library	454,560	3,835	430,160	2,119	-5%	-45%
Library	Cultural Arts Department	17,506	381	14,444	321	-17%	-16%
Library	Dove Library	1,288,533	15,487	1,432,492	11,200	11%	-28%
Library	Library Learning Center	32,960	766	192,000	421	483%	-45%
Library Total		**1,802,637**	**20,469**	**2,069,096**	**14,061**	**15%**	**-31%**
PD/Fire	Safety Center	**1,163,336**	**20,845**	**988,001**	**19,816**	**-15%**	**-5%**
Public Works	City Yard	100,861	474	88,335	729	-12%	54%
Public Works	CMWD M&O	197,920	754	189,440	86	-4%	-89%
Public Works	Fleet Yard	72,640	1,158	72,320	456	0%	-61%
Public Works	Parks Maintenance	29,474	117	39,694	149	35%	27%
Public Works Total		**400,895**	**2,503**	**389,789**	**1,420**	**-3%**	**-43%**

Table 3: Building and Facilities Inputs

Department	Building	2005 Electricity (kWh)	2005 Natural gas (therms)	2011 Electricity (kWh)	2011 Natural gas (therms)	% Change Electricity (kWh)	% Change Natural gas (therms)
Recreation	Calavera Community Center	70,318	-	54,970	-	-22%	-
Recreation	Carrillo Ranch	58,320	-	58,080	-	0%	-
Recreation	Harding Community Center	76,040	1,063	60,120	952	-21%	-10%
Recreation	Parks Total	773,551	2,122	914,888	3,006	18%	42%
Recreation	Senior Center	224,100	6,319	308,318	3,349	38%	-47%
Recreation	Stagecoach Community Center	215,360	1,602	195,920	1,424	-9%	-11%
Recreation	Swim Complex	202,520	31,116	247,240	34,266	22%	10%
Recreation	Trails	7,115	-	65,929	-	827%	-
Recreation Total		**1,627,324**	**42,222**	**1,905,465**	**42,997**	**17%**	**2%**
Housing and Neighborhood Services		**22,736**	**-**	**31,277**	**-**	**38%**	**-**
TOTALS		**6,895,876**	**100,968**	**8,374,670**	**111,053**	**21%**	**10%**

Public Lighting

This sector covers electricity consumed from three sources: traffic signals, streetlights, and other outdoor lighting. As shown in Table 4, streetlights make up the great majority of electricity consumption in this sector. Between 2005 and 2011, this sector consumed 4 percent less electricity, with the small increase in traffic signal and controller use more than offset by the declines in streetlight and outdoor lighting consumption. During this period, the city retrofitted its existing streetlights with more energy-efficient lamps.

Table 4: Public Lighting Inputs (kWh)

	2005	% of Total	2011	% of Total	% Change
Streetlights	4,652,801	86%	4,403,265	85%	-5%
Traffic Signals/Controllers	750,417	14%	768,784	15%	2%
Outdoor Lighting	20,988	0%	17,740	0%	-15%
TOTALS	**5,424,206**		**5,189,789**		**-4%**

Water and Wastewater Transport

This sector covers fuel consumed by pumps and other mechanisms used to convey water and wastewater: water delivery pumps, sprinklers and irrigation, sewage pumps, and recycled water pump stations. These systems all consumed electricity plus a small amount (170 gallons) of diesel fuel for water delivery generators.

Table 5 shows the electricity consumed by the City's water and wastewater transport systems in 2005 and 2011. During that time, electricity used by these systems increased by 29 percent. Much of that change can be attributed to a major increase in electricity used by recycle pump stations, as the city's recycled water facility came online in late 2005. Sewage pumps also used significantly more electricity (22% increase), as did sprinklers and irrigation (72% increase) although the amount was comparatively small. Water delivery pumps actually decreased in electricity consumption by 21 percent.

Table 5: Waste and Wastewater Transport Inputs (kWh)

	2005	*% of Total*	*2011*	*% of Total*	*% Change*
Recycle Pump Stations	418,980	23%	791,732	34%	89%
Sewage Pumps	1,038,941	57%	1,262,824	53%	22%
Water Delivery Pumps	360,237	20%	285,345	12%	-21%
Sprinklers/Irrigation	13,151	1%	22,554	1%	72%
TOTALS	**1,831,309**		**2,362,455**		**29%**

Vehicle Fleet

The inputs for this sector are all the vehicles used by the City. The key data used are fuel consumed and VMT, broken out by model year, vehicle type, and fuel type. CACP uses fuel consumption to calculate CO_2 emissions and VMT to calculate NO_2 and CH_4 emissions.

Although the vehicle fleet data from the City was broken down by department, the inputs were loaded into CACP as a single set for the entire City due to the time consuming nature of processing and entering this very detailed information.

Table 6 summarizes the inputs in 2005 and 2011 by vehicle and fuel type. There likely was some different categorization in terms of vehicle types in 2005, especially between light and heavy trucks, but overall fuel consumed and VMT by fuel type should be comparable. While there was a notable increase in diesel consumption and VMT, this was more than offset by a sharp decline in gasoline consumption and VMT.

Table 6: Vehicle Fleet Inputs

	2005		***2011***		***% Change***	
	Fuel (gal)	*VMT*	*Fuel (gal)*	*VMT*	*Fuel (gal)*	*VMT*
Diesel	**54,589**	**284,526**	**62,407**	**407,826**	**14%**	**43%**
Light Truck/SUV/Pickup	8,443	87,570	31,162	298,388		
Heavy Truck	46,146	196,956	31,245	109,438		
Gasoline	**207,286**	**2,580,657**	**167,345**	**1,965,416**	**-18%**	**-24%**
Passenger Car	99,396	1,487,843	85,874	931,979		
Motorcycle	2,374	N/A	1,787	74,024		
Light Truck/SUV/Pickup	88,329	982,401	76,663	938,733		

Heavy Truck	17,187	110,413	3,021	20,680
Hybrid	**-**	**-**	**3,581**	**137,096**
Passenger Car			2,478	108,136
Light Truck/SUV/Pickup			1,103	28,960

For the analysis in CACP, motorcycle inputs were grouped under passenger cars and hybrid fuel consumption was included with gasoline. Hybrid VMT was assumed at one-third of listed mileage to account for the likely reality of most hybrid miles being under electric power during low speed driving on local streets.

Mobile Refrigerants

Refrigerants come from stationary and mobile sources. Stationary sources are described under Scope 3 emissions.

Mobile source refrigerants come from estimated leakage from the vehicle fleet. The 2005 inventory undertook a very complex and thorough analysis based on attributes of each vehicle in the fleet, using the make, model, year, and time in service to determine refrigerant type and capacity and calculate estimated emissions. Ultimately, the GHG emissions from mobile refrigerants made up less than one percent of government operations emissions in 2005.

Given the small impact of these mobile refrigerants and the time already invested in the 2005 analysis, we used the 2005 output and pro-rated it for 2011 based on the relative sizes of the vehicle fleet. The 2005 fleet had 264 vehicles compared to 291 vehicles in the 2011 fleet, a 10 percent increase. Therefore, we estimated a 10 percent increase in GHG emissions from mobile sources for 2011.

Scope 3 Emissions

These emissions are not part of the government operations inventory as they are indirectly caused by the City.

Employee Commute

The City conducted an employee commute survey in 2009 which was applied to the 2005 inventory. Given that only two years elapsed between the survey and the year of this GHG emissions inventory update, it was assumed that the mode split, fuel consumption, and VMT data from the survey were still applicable. As with the 2005 inventory, the results from usable survey responses were extrapolated to apply to all City FTE. Since the 2011 FTE is 4.2 percent higher than the 2005 FTE, the fuel usage and VMT inputs for 2011 were 4.2 percent higher than in 2005.

Stationary Refrigerants

Stationary sources come from equipment installed in facilities. The 2005 inventory identified refrigerants used to service equipment in five buildings: Las Palmas, Harding Community Center, City Administration, the Safety Center, and the Senior Center. The

2011 inventory identified refrigerant use in four buildings: City Administration, City Hall, Dove Library, and the Senior Center. Refrigerants use was less in 2011 than in 2005, by around half (117.50 kg compared to 234.51 kg).

Solid Waste

The City undertook a thorough evaluation of solid waste generated by City facilities in 2005. Given that solid waste generation is typically correlated to number of people, we pro-rated the amount of solid waste based on the increase in FTE between 2005 and 2011, which was 4.2 percent.

Sectors Not Considered

The City does not operate port, airport, wastewater, or solid waste facilities, provide transit services, or generate electric power.

CONCLUSIONS

City operations in 2011 generated an estimated 8,205 metric tons CO_2e in GHG emissions, compared to an estimated 6,556 metric tons CO_2e in 2005, an increase of 25 percent, as shown in Table 7. City operations still accounted for a very small proportion of the GHG emissions from Carlsbad in 2011, making up 0.8 percent of emissions, the same as in 2005.

Table 7: Government Operations Emissions – 2005 vs. 2011 (metric tons CO_2e)

	2005	*2011*	*% Change*
Total emissions	6,556	8,205	25.2%
Carlsbad - Service Population	154,270	172,820	12.0%
Community emissions	925,248	1,030,353	11.4%
Government operations as proportion of community emissions	0.7%	0.8%	13.1%

The rate of growth in government emissions between 2005 and 2011 was higher than the rates of increase in Carlsbad's service population (12.0%) and communitywide GHG emissions (11.4%). The main reasons for the increase in government operations emissions appear to be twofold:

- A sharp increase in electricity consumed by water and wastewater transport services, especially recycled water pumps; and
- More emissions from electricity per megawatt hour, an issue that also affected communitywide emissions and further discussed in that memo.

Emissions by Sector

Emissions for government operations mainly came from buildings and facilities (42%) and the vehicle fleet (27%), followed by public lighting (21%) and water and wastewater transportation (10%), as shown in Table 8.

Compared to 2005, the proportion of city government emissions from buildings and facilities increased from 35 percent to 42 percent, increasing by 50 percent and making up more than two-thirds of the growth in emissions. As explained above, this is largely due to the opening of new buildings and recreation facilities since 2005.

Meanwhile, compared to 2005, the proportion of emissions from lighting and water/wastewater transport stayed largely the same, but the actual emissions from these sectors grew by 29 percent and 72 percent, respectively. Note that public lighting emissions increased despite that sector consuming 4 percent less electricity in 2011 compared to 2005. This outcome is a result of the much greater amount of emissions produced per megawatt hour of electricity in 2011 compared to 2005.

Meanwhile, vehicle fleet emissions decreased by 9 percent during the same period, due to major decreases in the miles driven and gallons of gasoline consumed.

Table 8: Emissions by Sector (metric tons CO_2e)

Source	*2005*	*% of Total*	*2011*	*% of Total*	*2005 to 2011 Increase*	*% Growth*	*% of Growth*
Buildings and Facilities	2,266	35%	3,410	42%	1,144	50%	69%
Vehicle Fleet	2,474	38%	2,253	27%	-221	-9%	-13%
Public Lighting	1,354	21%	1,747	21%	393	29%	24%
Water and Wastewater Transport	461	7%	795	10%	334	72%	20%
TOTALS	**6,556**		**8,205**		**1,650**	**25%**	

Emissions by Source

Most of the government operations emissions in 2011 came from electricity consumption, accounting for 65 percent of emissions, an increase from 59 percent in 2005. GHG emissions from electricity increased by 52 percent between 2005 and 2011, as shown in Table 9. Electricity was the source of almost all of the increase in emissions—more than the total increase, in fact, but offset by the decline in emissions from gasoline. Emissions from gasoline dropped by 17 percent, which caused gasoline to decline from 31 to less than 19 percent of government operation emissions between 2005 and 2011. Emissions from diesel grew by 13 percent and from natural gas and mobile refrigerants by 10 percent each, although all from relatively small bases.

Table 9: Emissions by Source (metric tons CO_2e)

Source	*2005*	*% of Total*	*2011*	*% of Total*	*2005 to 2011 Increase*	*% Growth*	*% of Growth*
Electricity	3,534	58.7%	5,362	65.4%	1,828	52%	111%
Gasoline	1,853	30.8%	1,538	18.7%	-315	-17%	-19%
Diesel / Propane	566	9.4%	641	7.8%	75	13%	5%
Natural Gas	537	8.9%	590	7.2%	53	10%	3%

Mobile Refrigerants	67	1.1%	74	0.9%	7	10%	0%
TOTALS	**6,557**		**8,205**		**1,648**	**25%**	

Sector 3 Emissions

Employee commute and solid waste emissions were estimated for 2011 based on pro-rating various indicators and loading them into the CACP model for calculation. See the Assumptions section above for more details.

- Employee commute emissions were estimated at 2,567 metric tons CO_2e in 2011, compared to 2,417 metric tons CO_2e in 2005, an increase of 6.2 percent.
- Stationary refrigerant emissions were estimated at 173 metric tons CO_2e in 2011, compared to 399 metric tons CO_2e in 2005, a decrease of 57 percent.
- Solid waste emissions were estimated at 144 metric tons CO_2e in 2005, the same as in 2011.